Exhibit A

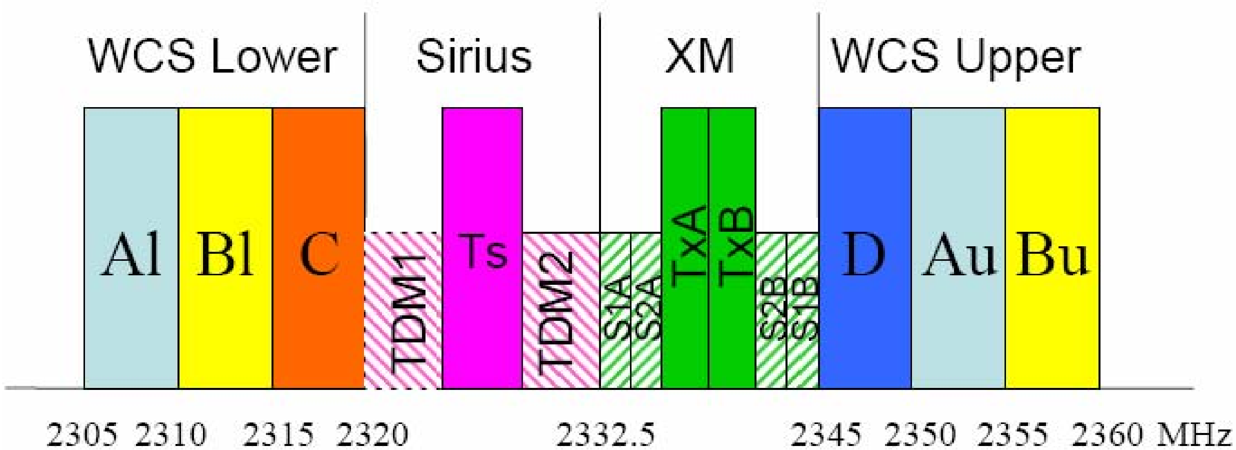
Transmitter Power, Ground Based Power Limits, and Out of Band Emissions Level Proposals for SDARS Repeaters, WCS Base Stations and User Terminals

1 Introduction

1.1 Band Plan

The WCS and SDARS services occupy 55 MHz of spectrum from 2305 MHz to 2360 MHz. The WCS service consists of six blocks of 5 MHz each, in the 2305-2320 MHz and 2345-2360 MHz bands. As shown in Figure 1 the following figure, there are paired blocks (A lower + A upper; B lower + B upper) that have been allocated on a regional basis (MEA service areas) and unpaired blocks (C and D) that have been allocated over very wide service areas (REAGs).[1] The SDARS service occupies the center 25 MHz (2320-2345 MHz) and is divided evenly between the two licensees, Sirius (2320-2332.5 MHz) and XM (2332.5-2345 MHz).

Figure1 WCS and SDARS Band Plan



TDM1 = Lower band Sirius satellite channel
TDM2 = Upper band Sirius satellite channel
Ts = Sirius COFDM terrestrial transmission channel
TxA and TxB= Two sub-bands (ensembles) of XM terrestrial transmission channels
S1A and S1B= Two ensembles of XM's first satellite
S2A and S2B= Two ensembles of XM's second satellite

Originally, all but 5 MHz of the spectrum shown in Figure 1 was proposed to be used exclusively for SDARS. In 1990, the FCC issued a *Notice of Inquiry* soliciting information to be used in identifying spectrum and developing technical rules and regulatory policies for Satellite DARS in the United States.[2] In coordination with the National Telecommunications Information Administration, the Commission supported U.S. efforts at 1992 World Administrative Radio Conference that ultimately allocated

[1] *Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service*, 12 FCC Rcd 10785, 10808 ¶ 45 (1997) ("*WCS Report and Order*").

[2] *Amendment of the Commission's Rules with regard to the Establishment and Regulation of New Digital Audio Radio Services*, Notice of Inquiry, 5 FCC Rcd 5237 (1990).

2310-2360 MHz for satellite DARS, and complementary terrestrial repeaters, in the United States.[3]

1.2 Differences Between Broadcast SDARS Service and Two Way WCS Service

1.2.1 Service and Network Requirements

1.2.1.1 SDARS Service and Network Requirements

The SDARS service is a mobile satellite service (MSS) serving the contiguous United States. Operating in the highly competitive marketplace for audio entertainment, this low price subscription service requires very high levels of service availability in order to ensure an almost uninterrupted listening experience, wherever the mobile or fixed customer may be.

Unlike subscribers to two-way mobile communications services, in a (one-way) broadcast service such as SDARS, the a customer has no capability to mitigate a service interruption (for example, by reinitiating a dropped call or waiting until a signal is available before placing a call). Therefore *any* small interruption to the listening experience is significant from a consumer perspective.

The SDARS service, therefore depends critically on maintaining higher levels of service availability than existing terrestrial only two way mobile wireless communications services. Both SDARS operators have used a mixture of technological innovation, as well as spatial, time, and frequency redundancy to develop and maintain greater than 99% service availability throughout the contiguous United States.[4] Recognizing that there are many locations where consumers have difficulty receiving satellite signals both SDARS operators augment the signal delivery with a limited number of ground-based repeaters in major cities. XM has deployed 800 repeaters to ensure that high availability levels are seamlessly achieved even in downtown areas with many tall buildings. The success of the SDARS hybrid satellite terrestrial architecture can be illustrated by contrasting the number of repeaters deployed to achieve >99% availability across the country with the much larger number of cellular base stations currently deployed by a typical cellular operator.[5] In augmenting the satellite delivery system, the SDARS repeaters cover less than 1% of the contiguous US land area, illustrating that the service is overwhelmingly delivered through satellite.

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3 47 C.F.R. § 2.106, international footnote S5.393 (formerly 750B).

4 Richard A. Michalski, Chief Engineer, Systems Engineering, XM Satellite Radio, Duy Nguyen , Senior Engineer, Systems Engineering, XM Satellite Radio, *A Method For Jointly Optimizing Two Antennas In a Diversity Satellite System*, AIA-2002-1996 (2002) available at http://www.aiaa.org/content.cfm?pageid=406&gTable=Paper&gID=144.

5 *See* CTIA at http://www.ctia.org/consumer_info/service/index.cfm/AID/10323 (>210,000 total base stations).

In areas where the satellite signal is impaired, such as dense urban areas, SDARS operators need to use ground-based repeaters to augment the signal delivery. XM's entire repeater network covers less than one percent of the United States land mass, but the repeaters are critical in high-traffic areas where satellite signals would be blocked and large numbers of SDARS customers routinely travel To illustrate this, Figures 1 and 2 show the results of drive tests performed by XM in May of 2004 in the Detroit metro area. Areas in blue indicate locations with an error free signal, areas in yellow indicate areas that are error free but with a low link margin, and areas in red represent locations that have errored signals. Figure 1 shows the results for the coverage provided by the combination of the satellites and repeaters; this composite coverage is 99.79% (reflected by the .21% bad coverage metric). Figure 2 shows the coverage provided by the repeaters alone, demonstrating that the area that is covered by the repeaters is 66% of the routes driven during this test.

The continuing success of the SDARS network in both ensuring seamless nationwide coverage while keeping subscription fees low, critically depends on maximizing the use of satellite infrastructure as opposed to terrestrial infrastructure with its associated higher operating costs . From a spectrum standpoint, this translates into maintaining a well understood adjacent band signal environment which minimizes degradation to the primary satellite signal reception from overload, intermodulation distortion ("IMD"), or out of band emissions.

The primary concern addressed in this document is therefore the impact of the proposed changes in Part 27 rules to allow WCS operators to transition from the successful fixed wireless access usage model upon which the original band plan was predicated to a broadband mobile wireless model that the FCC previously found unsuitable in the WCS bands.

Figure 1 XM Detroit Composite Satellite and Repeater Delivered Coverage.

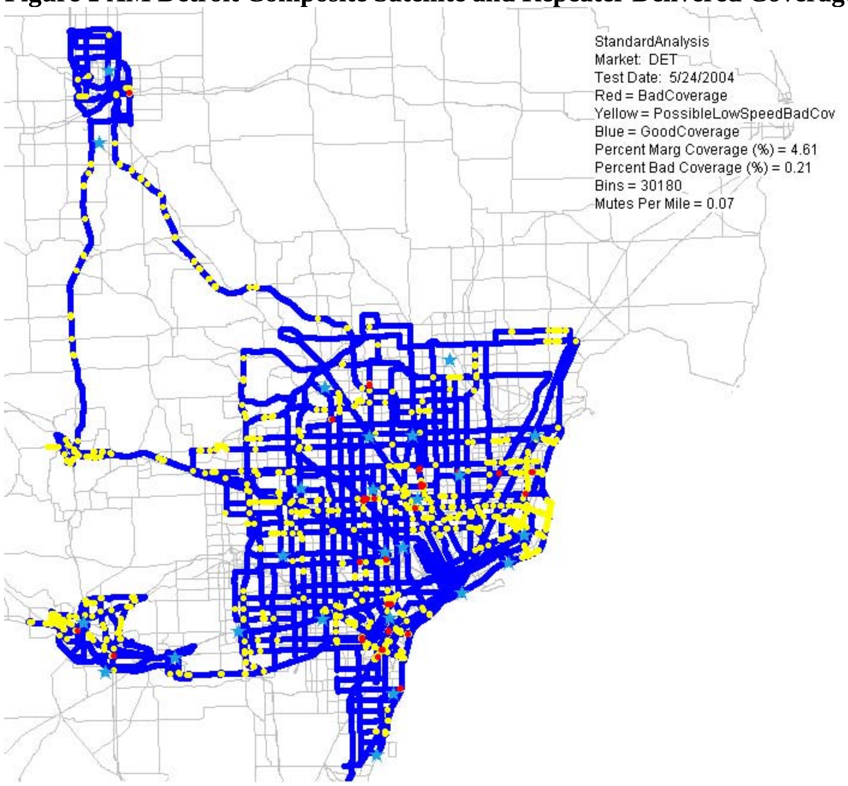
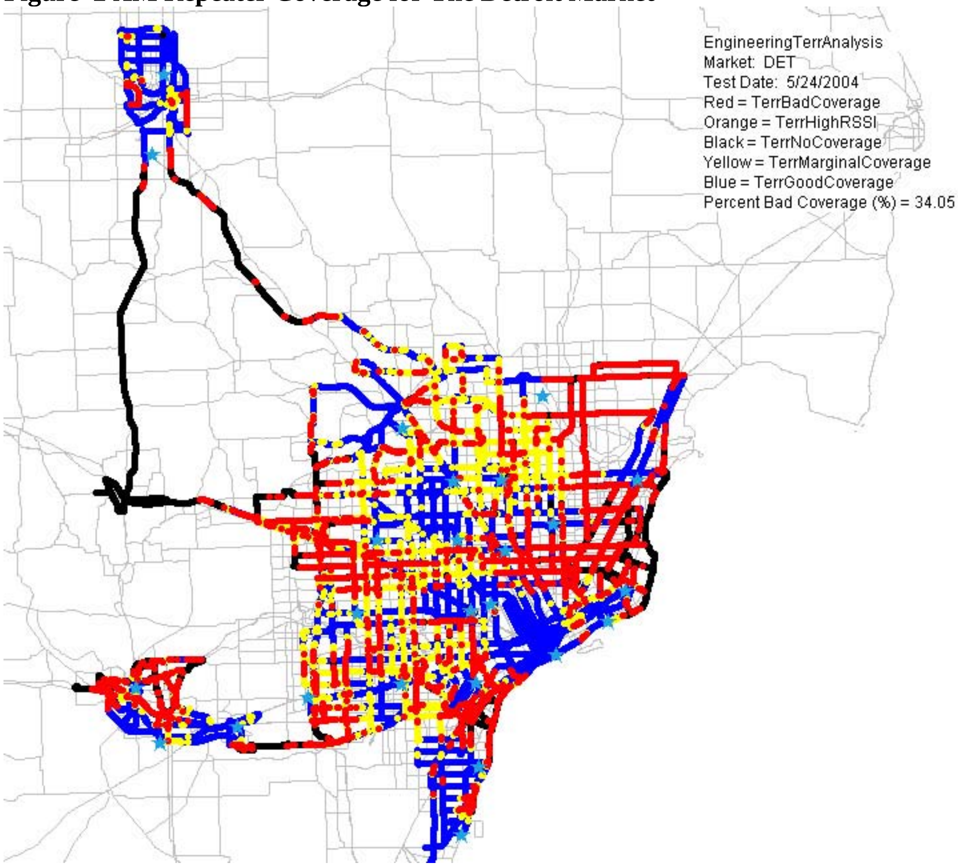


Figure 2 XM Repeater Coverage for The Detroit Market



1.2.1.2 WCS Service and Network Requirements

Essentially two network types are relevant in this discussion of the WCS band, namely fixed wireless access and mobile/ portable broadband.

1.2.1.2.1 Fixed Wireless Access

The networks that were originally envisioned to operate in this band are fixed wireless, point to point or point to multipoint systems. These networks are similar in structure to the SDARS repeater network in that they consist of lower density, centralized, relatively high powered, tall transmitter sites with little or no antenna down tilt utilizing fixed user terminals with external or internal antennas. Several networks of this type are currently deployed and successfully coexisting with SDARS service. The availability target for these kind of networks is almost as high as for SDARS (99%+), but the coverage areas are typically market based as opposed to the SDARS national footprint.

1.2.1.2.2 Mobile/Portable Broadband

Mobile broadband services have significantly different network and terminal characteristics from fixed systems.[6] As contrasted with the previously described fixed network architecture, the network to support mobile service will typically consist of many more base stations (because of the weaker user terminal reverse link and the more demanding propagation environment) which may be lower in height and routinely implement antenna down tilt as a self-interference control mechanism. In addition, high densities of mobile terminals operating at significant EIRP's are used. As contrasted to fixed terminals, these mobile devices could have uncontrolled proximity to SDARS users.

Because of the architecture and use differences of these mobile broadband services it can be anticipated that the eventual coverage availability, will be in the 95% range,[7] significantly less than in the fixed wireless or SDARS case.

1.2.2 Transmitter Requirements

1.2.2.1 SDARS Transmitter Requirements

SDARS transmitters are low volume platforms with an emphasis on moderate power design and "extreme" adjacent channel and out of band emission specifications. Significant cost and effort has gone into reducing the adjacent channel and out of band emissions of these transmitters to improve the quality of the immediately adjacent satellite signals (see Figure1). The current generation of XM repeaters was designed to meet a 75+10log(P) attenuation mask (where P is the **EIRP** in watts) which includes an additional margin of 15 dB to account for antenna gain. The equivalent transmitter output referenced specification would then be **90+10log(P)** (where P is the **transmitter output** power in watts). The allowed transmitter output power for an existing SDARS repeater, outside of the SDARS band, is therefore -60 dBm in a 1 MHz bandwidth.

1.2.2.2 WCS Base Station Transmitter Requirements

A number of vendors, such as Alvarion and Navini, supply base stations for use in the 2.3 GHz band A, B, C and D blocks . This equipment either uses a proprietary airlink format or, more recently, IEEE 802.16d WiMax based equipment. From the equipment certifications it can be determined that it is technically and commercially feasible to meet the existing out of band emissions for base stations of 80+10log(P) or -50 dBm in a 1 MHz bandwidth at the transmitter output. This is 10 dB less stringent that for current SDARS repeaters The vendors use innovative techniques, such as a variable guard band, to allow the maximum possible throughput in the C and D blocks, while meeting the appropriate out of band limits, Appendix [1] illustrates the adjacent block operation of one of these devices in the C block, clearly showing the variable guard band feature.

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[6] "Comparison of IEEE802.16 WiMax Scenarios with Fixed and Mobile Subscribers in Tight Reuse," Siemens AG, C.F.Ball *et al.*, IST Mobile and Communications Summit, June 2005.

[7] LCC International, Inc., *H Block MS Overload Analysis*, (Dec. 1, 2004), *available in* Comments of Nextel Communications, Inc., WT Docket No. 04-356 (filed Dec. 8, 2004).

1.2.2.3 WCS Fixed User Terminal Transmitter Requirements

A number of vendors, such as Alvarion and Navini, supply fixed user terminals for both indoor and outdoor use in the 2.3 GHz band A, B, C and D blocks. This equipment either uses a proprietary airlink format or, more recently, IEEE 802.16d Wimax based equipment. Power control is a typical feature. From the equipment certifications it can be determined that it is technically and commercially feasible to meet the existing out of band emissions for these terminals of 80+10log(P) or -50 dBm in a 1 MHz bandwidth for all the WCS blocks, including the C and D blocks. As with the base stations, the vendors use innovative techniques, such as a variable guard band to allow the maximum possible throughput in the C and D blocks, while meeting the appropriate out of band limits.

1.2.2.4 WCS Mobile User Terminal Transmitter Requirements

XM is not aware of any mobile terminals currently available that meet the specifications for this band.

1.2.3 Receiver Requirements

1.2.3.1 SDARS Receiver Requirements

SDARS receivers are designed to allow mobile reception of relatively weak satellite signals (from 37,000 km in space) as well as to take advantage of any available repeater signals. In order to receive the satellite signals, whose levels can be as low as -102 dBm, the satellite receiver must be more sensitive than a typical terrestrial mobile receiver. The receiving noise floor for an SDARS receiver has been measured at -113 dBm (in the 4 MHz bandwidth used).[8] The receiver types fall into a variety of categories including factory and aftermarket installed in cars, and portable. While the detailed performance of these radios varies by product generation, they all are required to process a wide dynamic range of signals in order to realize the greater than 99% system availability mentioned in 1.2.1.1.

1.2.3.2 WCS User Terminal Receiver Requirements

A number of vendors, such as Alvarion and Navini, supply fixed user terminals for both indoor and outdoor use in the 2.3 GHz band A, B, C and D blocks. This equipment either uses a proprietary airlink format or, more recently, IEEE 802.16d WiMax based equipment.

One way to estimate the overload performance of WCS terminals, fixed or mobile, is to compare the protection level required in terms of the difference in signal level between the wanted signal level and the interfering signal level as a function of the frequency separation between the two signals.

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[8] *See* Exhibit C, Appendix 1.

For the WCS A upper block there is a 5 MHz frequency separation between the block and the XM S1B signal. The test results for the XM receiver using a 99% duty cycle WiMax signal, which is similar to the continuous OFDM transmit signal used by the DARS repeater, show an approximate 60dB protection level (-100dBm wanted signal and -40dBm interfering signal).

The worst case frequency separation between the SDARS repeater signal and the closest WCS frequency block is ~4 MHz away so a similar level of protection capability is reasonable to assume for the WCS receiver of 60dB.

Given the lack of a WiMax hardware platform we have looked at other references to understand the WiMax receiver sensitivity. In these documents (see Figure 3 below), the consumer unit receiver sensitivity level sited is -95.2 dBm. If one assumes a receiver implementation similar to an SDARS receiver providing 60dB of protection to an interferor that is 5 MHz away, then all WCS receivers should be protected from an SDARS interferor up to a power level of approximately **-35 dBm**.

Figure 3 WiMax Link Budget

Table 2.8 Sample Link Budgets for a WiMAX System

Parameter	Mobile Handheld in Outdoor Scenario		Fixed Desktop in Indoor Scenario		Notes
	Downlink	**Uplink**	**Downlink**	**Uplink**	
Power amplifier output power	43.0 dB	27.0 dB	43.0 dB	27.0 dB	A1
Number of tx antennas	2.0	1.0	2.0	1.0	A2
Power amplifier backoff	0 dB	0 dB	0 dB	0 dB	A3; assumes that amplifier has sufficient linearity for QPSK operation without backoff
Transmit antenna gain	18 dBi	0 dBi	18 dBi	6 dBi	A4; assumes 6 dBi antenna for desktop SS
Transmitter losses	3.0 dB	0 dB	3.0 dB	0 dB	A5
Effective isotropic radiated power	61 dBm	27 dBm	61 dBm	33 dBm	A6 = A1 + $10\log_{10}$(A2) − A3 + A4 − A5
Channel bandwidth	10MHz	10MHz	10MHz	10MHz	A7
Number of subchannels	16	16	16	16	A8
Receiver noise level	−104 dBm	−104 dBm	−104 dBm	−104 dBm	A9 = −174 + $10\log_{10}$(A7*1e6)
Receiver noise figure	8 dB	4 dB	8 dB	4 dB	A10
Required SNR	0.8 dB	1.8 dB	0.8 dB	1.8 dB	A11; for QPSK, R1/2 at 10% BLER in ITU Ped. B channel
Macro diversity gain	0 dB	0 dB	0 dB	0 dB	A12; No macro diversity assumed
Subchannelization gain	0 dB	12 dB	0 dB	12 dB	A13 = $10\log_{10}$(A8)
Data rate per subchannel (kbps)	151.2	34.6	151.2	34.6	A14; using QPSK, R1/2 at 10% BLER
Receiver sensitivity (dBm)	−95.2	−110.2	−95.2	−110.2	A15 = A9 + A10 + A11 + A12 − A13
Receiver antenna gain	0 dBi	18 dBi	6 dBi	18 dBi	A16
System gain	156.2 dB	155.2 dB	162.2 dB	161.2 dB	A17 = A6 − A15 + A16
Shadow-fade margin	10 dB	10 dB	10 dB	10 dB	A18
Building penetration loss	0 dB	0 dB	10 dB	10 dB	A19; assumes single wall
Link margin	146.2 dB	145.2 dB	142.2 dB	141.2 dB	A20 = A17 − A18 − A19
Coverage range	1.06 km (0.66 miles)		0.81 km (0.51 miles)		Assuming COST-231 Hata urban model
Coverage range	1.29 km (0.80 miles)		0.99 km (0.62 miles)		Assuming the suburban model

2 Establishing Appropriate Power and OOBE Levels

2.1 SDARS Repeaters, Base Stations

2.1.1 Introduction

The negative implications of the WCS Coalition's proposal to allow 2 kW blanket licensing of transmitters without additional constraints were discussed in Sirius and XM's previous ex parte filing.[9] The material presented here expands on that discussion with the objective of establishing appropriate power and out of band emission limits for WCS base stations and SDARS repeaters.

2.1.2 SDARS Repeaters and WCS Base Station Power Levels

It has been previously demonstrated that SDARS repeaters and WCS fixed wireless systems can coexist under the existing rules.[10] Such WCS fixed wireless installations generate well understood interference geometries and are similar to the SDARS repeater network in terms of the architecture.

Sirius has shown in a previous filing that ground-based limits offer the most effective solution in controlling inter-band interference between SDARS and WCS.[11] Expanded information regarding the proposed use of predictive tools in the application of ground based limits is provided in Appendix [2] of this exhibit.

In order to be effective, such limits must directly relate to the actual impact on the user terminal which, in the case of SDARS receivers, varies by WCS block (See Exhibit C, Section III). For example, the XM receiver performance is significantly degraded for an interfering signal in the "D" block). This is due to the absence of any guard band between this block and the adjacent SDARS satellite channel, S1B, significantly reducing the effectiveness of any practical receiver filtering.

XM supports Sirius's modification of its original proposal (which envisaged some form of guard band for the C and D blocks as is currently implemented in WCS fixed wireless equipment, see Appendix 1) into two distinct ground-based limits, one for the A and B blocks and one for the C and D blocks. This approach recognizes the reality that there is no defined guard band between the C and D blocks and the Sirius and XM SDARS allocation. XM has established that a common limit (for A and B and C & D blocks) can only be applied with the D block and XM. This key issue of the lack of a guard band is very similar to that identified by AT&T in the AWS proceeding.[12]

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9 *Ex Parte* Presentation of Sirius Satellite Radio Inc.and XM Radio Inc., Docket 95-91 (filed Nov. 30, 2007) ("*November 30 Sirius and XM* Ex Parte").

10 *See* Comments of XM Radio Inc., IB Docket No. 95-91, Exhibit A (filed Dec. 14, 2001).

11 *Ex Parte* Presentation of Sirius Satellite Radio Inc. and XM Radio Inc., Docket 95-91, Annex 2 (filed Dec. 05, 2007).

12 *See* Reply Comments of AT&T Inc., WT Docket 07-195, Section II(B) (filed Jan. 14, 2007) ("*AT&T AWS-3 Reply Comments*").

XM has not been able to obtain detailed WCS mobile receiver data that would help further refine its proposal for limits for SDARS repeaters. However, an estimate of the expected overload levels of mobile WCS terminals can be used in establishing the associated ground-based level proposal for SDARS repeaters. This approach is based on assuming that WCS terminals have similar performance limits to SDARS receivers.

2.1.2.1 Proposed Power Limits for SDARS Repeaters

Based on the analysis of expected WCS mobile receiver performance (see Section 1.2.3.2), XM is proposing a ground-based power limit for SDARS repeaters of 110 dBuV/m (-35 dBm equivalent isotropic received power). The appropriate bandwidth for this measurement would be 5 MHz in the case of XM. The measurement would be based on average power and consistent with the measurement procedures outlined in Section 3. These repeaters would be subject to FCC Certification.

XM proposes that SDARS repeaters at 2W EIRP or below be exempted from the ground-based limits proposed here. These repeaters would be subject to FCC Certification.

2.1.2.2 Proposed Power Limits for WCS Base Stations

Based on the measured performance of SDARS receivers (Exhibit C), XM is proposing the following ground based power limits for WCS base stations:

- A and B blocks 100 dBuV/m (-44 dBm isotropic equivalent power)
- C and D blocks 90 dBuV/m (-55dBm isotropic equivalent power)

These field strengths would be established for the nominal WCS channel signal bandwidth (i.e. 5 MHz).and measured at 2 meters AGL. These values, XM believes, represent a reasonable compromise between the scale of receiver performance degradation that XM can accept and the need for WCS operators to provide adequate coverage.

Appendix 3 provides some simplified insight into the potential application of these rules and their impact on the transmitter power/height/down tilt trade space. Tables are provided showing the predicted field strength level as a function of distance from a base station at a variety of antenna heights. Two different down tilt situations are modeled (1 degree, representing an example value for a fixed wireless base station and 10 degrees for a base station deployed to support a mobile service) using a simple free space path loss model, together with the ITU-F1336 antenna model for a 90 degree sector antenna.[13] The EIRP chosen is 2,000 watts and the distance is predicted out to 1 km. Beyond 1 km the site specific clutter is likely to reduce the applicability of the free space model. Within a 1 km radius the model serves to illustrate the relationships among the various parameters.

The general trend of areas exceeding the 100 dBuV/m limit are clear from these tables, namely, for the case of 1 degree down tilt, an antenna height of 50 meters or above essentially meets the 100 dBuV/m limit without exception at 2 kW. In practice the

[13] ITU F1336, *recommends* 3.2, with improved side lobe performance.

propagation loss would be expected to be greater than free space as the distance from the site increased and so the 30 meter antenna height case would most likely also meet the limit as the distance from the site at which the limit is exceeded with the simple free space model is greater than 850 meters.

Another general trend that can be discerned is that, at a given down tilt and power, as the height is increased, the area where the limit is exceeded moves further out from the base station and “flattens out”, i.e., the taller the site the more likely that additional excess path loss will further reduce the ground field strength level.

The dramatic effect of increased down tilt is seen in the 10 degree down tilt table. The effect here, at lower antenna heights, is to move the area where the limit is exceeded closer to the base station where the probability of excess path loss due to clutter is less. In these circumstances, power and/or down tilt would have to be adjusted for compliance, depending on how exclusion zones are allowed for.

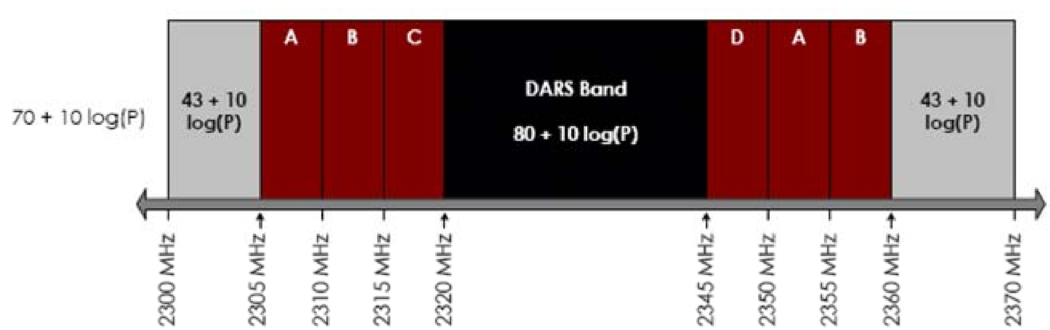
In practice, the actual predictions would use more accurate and sophisticated network planning tools as is described in more detail in Appendix 2.

2.1.3 SDARS Repeaters and WCS Base Station Out of Band Emissions Limits

2.1.3.1 Introduction

The current out of band limits for WCS base stations are illustrated in Figure 4. The out of band emissions limits for SDARS repeaters currently exceed the 80+10log(P) (-50 dBm equivalent power) by 15 dB due to the SDARS requirement for additional margin to take into account antenna gain.

Figure 4 Out of Band Emissions for WCS Fixed Service[14]



[14] From Navini Networks Equipment Type Acceptance filing.

2.1.3.2 Proposed Limits for SDARS Repeater Out of Band Emissions

XM and the WCS Coalition agree on relaxing the out of band emissions limit for SDARS repeaters and WCS base stations[15], specified at the transmitter output.

XM is therefore proposing an out of band emission specification of 75 +10 Log (P) for SDARS repeaters, where P is the transmitter output power in watts. This is equivalent to a transmitter output power level of -45 dBm. The measurement bandwidth is 1 MHz and the measurement type is average power. This specification would also apply to all SDARS repeaters. The limit is measured at the transmitter output and needs to take into account the measurement requirements outlined in Section .3.

2.1.3.3 Proposed Limits for WCS Base Station Out of Band Emissions

XM is proposing an out of band emission specification of 75 +10 Log (P) where P is the transmitter output power in watts. This is equivalent to a power level of -45 dBm.. The power measurement bandwidth is 1 MHz and the measurement is average power, subject to the burst measurement requirements outlined in Section 3 of this exhibit.

2.2 WCS User terminals

2.2.4 Introduction

2.2.5 Fixed WCS User Terminals

XM has established that current fixed wireless deployments and equipment certifications of WCS fixed user terminals (utilizing innovative guard band implementations in "C" block) present little to no issue for SDARS operations in their current form. Accordingly, XM is proposing exemption from the ground-based limits required for such devices operating within EIRP limits and is supporting a relaxation of 5 dB in the out of band limits that such devices need to meet. XM believes this relief should further allow cost reductions in fixed user equipment, thereby further facilitating fixed wireless deployment in underserved rural markets.

2.2.6 Proposed Power Limits For Fixed User Terminals

XM proposes that, a fixed user terminal be defined as:

Equipment which transmits only when it is connected to AC power directly, or through a transformer. A fixed station does not transmit when connected only to a battery, whether internal or external.

[15] *See Ex Parte* Presentation of WCS Coalition, Docket 95-91, Slide 6 (filed Nov. 14, 2007).

2.2.6.1 Proposed Power Limits For Fixed User Terminals Operating Above 2 Watts EIRP

XM proposes that fixed user terminals operating above 2W EIRP should be subject to the same ground based limits established for WCS based stations, namely:

For the A and B blocks 100 dBuV/m (isotropic equivalent power of -44 dBm)
For the C and D blocks 90 dBuV/m (isotropic equivalent power of -55 dBm)

Measured at 2 meters above ground in a 5 MHz bandwidth.

2.2.6.2 Proposed Power Limits For Fixed User Terminals Operating at 2 Watts EIRP or Below

Fixed user terminals operating at 2W EIRP or below are exempt from the ground-based limits proposed here. These terminals would be type accepted and utilize power control to adjust the output power to that sufficient to maintain the link.

2.2.7 Proposed Limits For Fixed User Terminal Out of Band Emissions

XM proposes that all fixed user terminals be subject to an OOBE limit of 75+10log(P) (-45 dBm power), measured in a 1 MHz bandwidth. This requirement is 5 dB less stringent than currently in force.

2.3 Mobile/Portable User Terminals

2.3.8 Introduction

The negative implications of the WCS Coalition's proposal to relax mobile out of band emissions limits without additional constraints were discussed in Sirius and XM's previous ex parte filing.[16] The material presented here sets forth additional implications and describes an appropriate framework for establishing the possible performance parameters for a mobile service, given the realities of the current WCS band plan

2.3.9 Proposed Power Limits for Mobile and Portable Devices

In the case of a mobile or portable user terminal as now being proposed by the WCS coalition, XM believes the most appropriate way to specify power and out of band limits is to directly relate them to the actual impact on the affected terminals. XM is proposing use of an interference coordination distance of 3 meters in establishing the permissible EIRP and OOB limits for WCS mobile and portable user terminals. XM believes this coordination distance represents the absolute maximum interference radius around mobile WCS user terminals that the SDARS service can tolerate without significant

[16] *November 30 Sirius and XM* Ex Parte.

service disruption. This distance can be contrasted with the even more stringent 1 meter limits proposed in submissions in the AWS proceedings.[17]

In deriving the mobile EIRP limits, the measured results for XM reference receiver overload are used in conjunction with an estimate of path loss at a 3 meters separation to calculate the maximum EIRP that a user terminal could have without muting the reference receiver. The path loss at 3 meters is calculated by adding 3 dB to the value calculated using a free space model to account for various coupling losses[18] This approach to path loss calculation has also been confirmed in the experimental program (see Exhibit C, Section III, Figure 5). These results are calculated as a function of the serving satellite signal and the WCS signal duty cycle.

The mobile EIRP proposal is derived as follows:

For the “A” and “B” blocks XM has determined the WCS mobile / fixed receiver overload level from interpreting laboratory and field measurements of receiver performance.[19] In doing so XM has attempted to take into account the wide range of signal conditions under which interference would be experienced and to balance the needs of WCS and SDARS operators. Accordingly, a field strength of 100 dBuV/m (-44 dBm isotropically received power)) has been selected as the target level at the receiver.

At the proposed coordination distance of 3 meters, the calculated path loss is 52.2 dB using the free space + 3dB approach..

The mobile EIRP for the A and B blocks can therefore be no more than:

-44 + 52.2 dBm = **8.2 dBm** .

XM is proposing **10 dBm (10 milliWatts)** as the mobile limit for this case.

For the “C” and “D” blocks, the receiver overload level (in isotropically received power units) has been selected in the same fashion as for the A and B blocks. A field strength of . 90 dBuV/m.(-55 dBm isotropically received power) has been selected.

For a 3 meter coordination distance, the mobile EIRP can therefore be no more than:

-55 +52.2 dBm. = **-2.8 dBm**

XM is proposing **0 dBm (1 milliWatt)** as the mobile limit for this case**.**

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17 *See, e.g., AT&T AWS-3 Reply Comments* at Section II(A).

18 *See* Comments of Verizon Wireless, WT Docket 07-195, Attachment A (filed Dec. 14, 2007).

19 *See* Exhibit C.

2.3.10 Proposed Limits for Mobile / Portable User Terminal Out of Band Emissions

XM is proposing a new "balanced" approach to setting out of band limits for mobile devices. In this approach the overload and out of band limits are established at the same interference distance of 3 meters. The receiver impairment criteria used for the out of band limit estimation is the generally accepted 1 dB rise in satellite noise floor[20]. This level is established using the measured satellite noise floor (see Exhibit C, Appendix [1]). A bandwidth of 1 MHz is used.

The out of band emissions limit is derived as follows:

First, the noise floor is estimated:

The measured noise floor in the XM part of the SDARS band is given in Exhibit [C] ,Appendix [1] as -113 dBm in a 4 MHz bandwidth.

To normalize the value to the 1 MHz bandwidth used for OOBE limit specification a correction factor of 10*log(4/1) is applied to the value.

Corrected Noise Floor = -113 – 6.02 dBm = ~-119 dBm in a 1 MHz bandwidth..

The interference level at the receiver that would cause a 1 dB rise in this noise floor is calculated as follows:

IL_{WCSOOB} =10*log[10^($SDARS_{NF}$ /10){10^(1/10)-1}]=-124.9 dBm in a 1 MHz bandwidth.

Where

$SDARS_{NF}$ = The SDARS measured noise floor in dBm at 1MHz bandwidth.

IL_{WCSOOB}= The level of emissions from the WCS mobile, in dBm, falling into the SDARS band in a 1 MHz bandwidth .that would cause a 1 dB rise in the SDARS noise floor at the receiver.

At a coordination distance of 3 meters, the path loss is 52.2 dB using the free space + 3 dB approach.

Accordingly, the out of band emissions at the WCS mobile output can be no more than:

-124.9 dBm + 52.2 dB = -72.7 dBm, measured in a 1 MHz bandwidth.

[20] *See* "Compatibility of Services Using WiMax Technology with Satellite Services in the 2.3-2.7 GHz and 3.3-3.8 GHz Bands," WiMax Forum, Section 4 (2007).

This level is equivalent to a required attenuation level of 102.7 + 10log(P) where P is the average transmitter power in watts(measured in 5 MHz), measured in accordance with the requirements outlined in Section 3.

3 Power Measurement Issues Associated with Proposals

3.1 Introduction

In order to ensure that the proposed power limits are implemented in a consistent and fair way, it is necessary to take into account significant differences in the transmitted waveforms between SDARS repeater and WCS base station and user terminals. Specifically, WiMax power measurements depend on the extensive use of frame synchronized, time gated power measurements[21] whereas SDARS repeater measurements are based on simpler, continuous measurements.

3.2 Proposal for Power Measurements for SDARS Repeaters

SDARS transmitter output power and out of band emissions will be measured using an average power reading spectrum analyzer. The transmitter power will be measured in the XM channel bandwidth which is 5 MHz. The out of band power will be also be measured in a 1MHz bandwidth using an average reading spectrum analyzer.

In addition to the measurement of the average output power, the Complementary Cumulative Distribution Function (CCDF)[22] of the SDARS transmitted signal will be measured at the transmitter output. The SDARS output CCDF will not exceed a peak to average ratio of 8 dB when measured at the 0.1% probability level.

3.3 Proposal for Power Measurements of WCS Base Stations and User Terminals

In measuring WCS base station and user terminal transmit and out of band powers, the power measurement shall include a time gating method to establish the power (peak or average) during any burst period. XM believes that a similar approach to defining a peak power limit as that proposed for SDARS repeaters above (i.e. peak to average ratio, based on some probability of occurrence) is needed for WCS transmissions and would welcome comments from the WCS parties as to proposed values.

[21] *See, e.g.,* "Power Measurement and Power Calculation of IEEE 802.16 Wimax™ OFDMA signals," Rohde and Schwarz, Application Note 1EF60, *available at* http://www.rhode-schwarz.com.

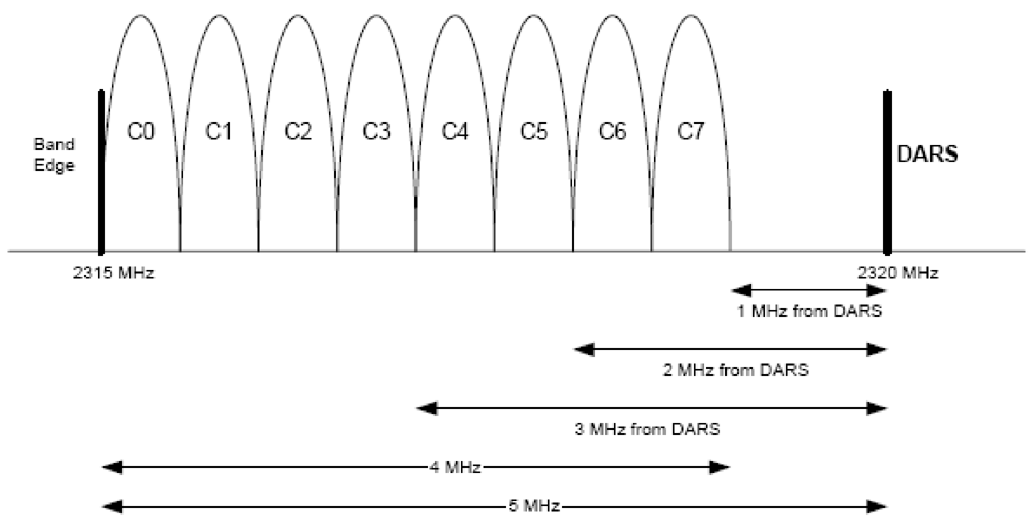
[22] *See, e.g.*, "The Crest Factor in DVB-T (OFDM) Transmitter Systems and its influence on the Dimensioning of Power Components," Rohde and Schwarz, Application Note 7TS02, *available at* http://www.rhode-schwarz.com.

Appendix 1

Examples of Guard Band Use in WCS Fixed Wireless Equipment

Navini Networks 2.3-BTS3A-R1[23]

Output Channels



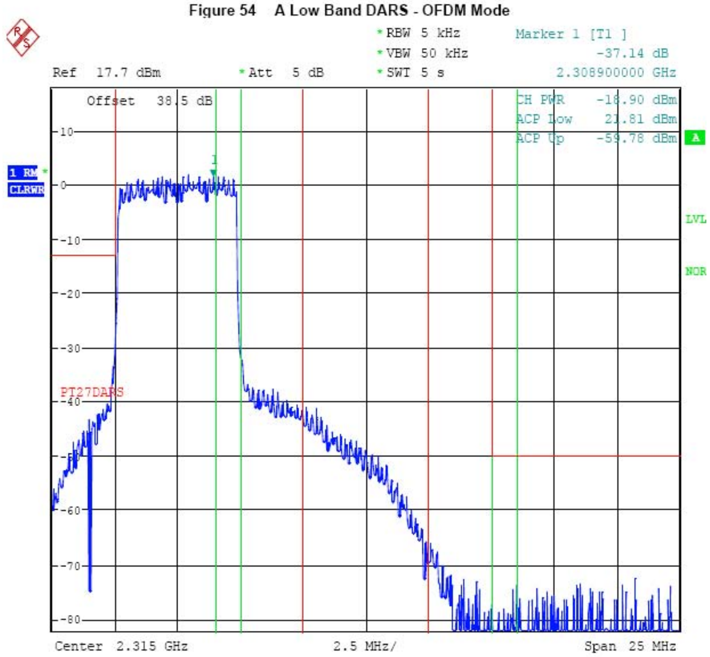
8 Carrier BTS Signal Operating in WCS C Band

[23] From FCC equipment certification documents

Example Output Spectrum

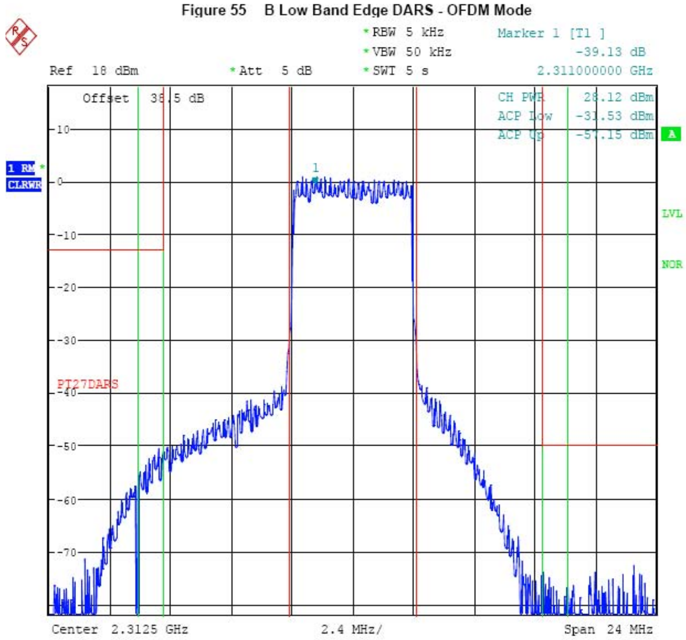
A Block (nominal bandwidth)

Figure 54 A Low Band DARS - OFDM Mode



B Block (nominal bandwidth)

Figure 55 B Low Band Edge DARS - OFDM Mode



C Block (reduced bandwidth)

Figure 57 C Band DARS – OFDM 24 Subcarrier/+28 dBm Mode

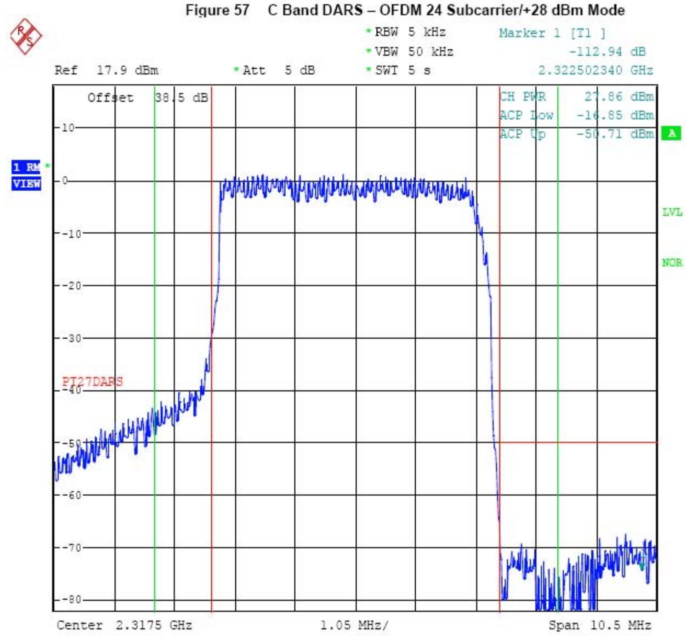
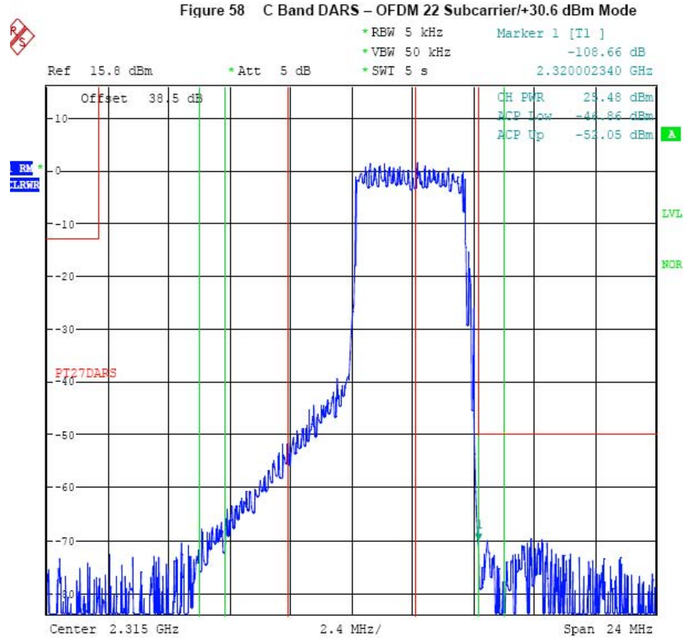


Figure 58 C Band DARS – OFDM 22 Subcarrier/+30.6 dBm Mode



Appendix 2

1 Critical Factors for RF Propagation Modeling

This document briefly describes several factors that must be considered when specifying a propagation modeling method to predict ground level power flux density. A proposal or recommendation for how to specify or model each of these factors is also provided.

The following factors must be considered when selecting and using computer-based propagation models to predict received signal strength[24]:

- Propagation model and path loss calculation technique
- Frequency range of operation
- Time and location variability
- Terrain elevation modeling
- Land use modeling (clutter)
- Prediction confidence margin
- Model calibration with measured data
- Representation of physical equipment (transmitter powers, antenna patterns & gains, line losses, etc.)

1.1 Model Selection and path loss calculation technique:

The purpose of the RF propagation model is to predict the excess path loss (XPL) that occurs along the propagation path in addition to free space path loss. The models listed in the table below are available and can be used for the SDARS / WCS frequency band.

Propagation model type	Frequency Range (MHz)
Free space + RMD	30-60,000
TIREM-EDX	30-40,000
ITUR-1546	30-3000
Longley-Rice v1.2.2	30 – 20,000
Anderson 2D v1.00	30 – 60,000

Proposal: The model proposed for WCS / SDARS received power prediction is the Free space + RMD (Reflection plus Multiple Diffraction Loss) model. This model can be configured to use terrain obstacle factors, variability factors, and urban and foliage loss factors to calculate XPL. It is an appropriate model to use for microwave path design, or area-wide system studies operating at microwave frequencies (such as MDS) where the receive sites are not random or mobile locations, but engineered receive sites with

[24] The propagation modeling described here can be done using EDX Signal Pro®; however, other modeling tools and software are available that provide the same functionality.

directional antennas[25]. This model would be appropriate for use in predicting ground level power flux densities.

1.2 Time and location variability

Propagation modeling provides a statistical estimate of the received signal level at a location. Signal level statistical parameters for time and location can be varied to specify the margin of the calculation results. When specifying a time percentage, the calculated received power or voltage levels will be exceeded at least that percentage of time for similar propagation paths. Similarly, specifying a location percentage will produce results with received power or voltage levels exceeded at least the specified percentage of locations for similar propagation paths.

Proposal: The time and location percentage parameter proposed for both time and location is 50%. The statistical results for received signal strength for time and location, for all areas with similar propagation path losses, will then be unbiased about the predicted mean.

1.3 Terrain Elevation Modeling

Propagation modeling tools use digitized elevation maps to place transmitters and receivers on the ground, and with specified antenna heights AGL can determine radiation center and receive antenna heights above mean sea level (AMSL). This information is then used to calculate line-of-site propagation, diffraction effects over terrain as well as terrain blockage of the propagation path between transmitter and receiver.

Proposal: The USGS 10/30 meter terrain databases are proposed for use in conjunction with the propagation model. These databases were developed from 1:24,000-scale 7.5-minute (or better) topographic maps by the USGS[26].

1.4 Land Use Modeling (Clutter)

Propagation modeling tools use land use / land cover (LULC) data to add attenuation caused by local clutter when calculating the received signal at the receiver. Several types of clutter may contribute to the signal’s attenuation, so for each clutter type a corresponding mean attenuation and height above ground level must be specified. In addition, the attenuation value for each clutter type may vary with frequency.

Proposal: The LULC data that is available from the USGS for the United States are proposed for use in conjunction with the propagation model. This data was derived from 1:250,000 and 1:100,000 scale maps and has been formatted into a grid spacing of approximately 200 by 200 meters[27]. The table below shows ten land use categories derived form the USGS LULC data, with values for average clutter height above ground level (ft) and losses from clutter at the receiver for the WCS and SDARS band.

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[25] EDX Signal Pro® Reference Manual, Appendix A. Propagation Models, page A-2.
[26] EDX Signal Pro® Reference Manual, Appendix B, page B-1.
[27] EDX Signal Pro® Reference Manual, Appendix E, page E-2.

	Land Use Category	Clutter Height (ft)	Losses from Clutter at Receiver (dB)
1	Open land	0	8
2	Agricultural	0	20
3	Range land	0	12
4	Water	0	0
5	Forest	15	25
6	Wetland	0	5
7	Residential	5	23
8	Mixed urban / dwellings	15	23
9	Commercial / industrial	20	23
10	Snow and ice	0	0

1.5 Prediction Confidence Margin

The prediction confidence margin is a parameter provided in some modeling tools that allows a prediction bias to be added to the calculated received signal level. This is useful, for example, to assure that the signal levels of the actual system will be at least as strong as the signal levels predicted by the model. If the confidence margin is set to 0 dB, the model will predict the expected received signal level without bias.

Proposal: It is proposed that the prediction confidence margin be set to 0 dB so that the prediction of received signal level is unbiased. If measured data is available that specifies the actual received signal level in the area being modeled, the prediction confidence margin can be adjusted to bring the propagation model into agreement with the actual measured data.

1.6 Model Calibration with Measured Data

Propagation modeling tools can provide the means to compare the received signal levels predicted by the model with actual real-world data. Receive signal level data are collected, with location coordinates specified for each point on the map where the received signal was measured and recorded. This recorded signal level data can then be compared with the corresponding predictions of signal levels at these locations as determined by the model. A statistical comparison of these data sets can reveal if there is a bias or other variances in the modeled data, relative to the measured data.

Proposal: It is proposed that for each RF coverage area of interest, the propagation model first be used (with zero-bias prediction confidence margin) to predict the areas with the strongest signal on the ground. Actual received signal strength data can then be collected in these areas and statistically compared with the model’s predictions. The prediction confidence margin of the model must then be adjusted to bring the expected prediction levels into agreement with the measured data.

1.7 Representation of Physical Equipment

Propagation modeling tools provide the ability to input parameters specific to the particular hardware of the systems that are being modeled. In addition to antenna heights and locations, measured antenna gain patterns can be used to account for signal gains or losses that occur when the signal path passes through the antenna at various elevation and azimuth angles. Conducted transmitter power, cable losses and antenna gain patterns can then be used to determine the power radiated from the antenna at different aspect angles between the transmitter and receiver.

Proposal: It is proposed that the digitized antenna gain patterns, which are provided by each antenna's manufacturer, be used in the propagation modeling. This antenna gain pattern data, along with the conducted transmitter power and cable losses for each transmitter site can then be used to model the radiated power from each transmitter site.

Appendix 3
Ground Based Field Strength Examples

- “Fixed Wireless” (Downtilt = 1 degree)
- “Mobile Wireless” (Downtilt = 10 degree)

1 Degree Downtilt Field Strength (dBuV/m)

	Antenna Height (m, AGL)							
Downtilt 1 degree	**5**	**15**	**30**	**50**	**70**	**90**	**110**	**140**
Distance (m)								
5	**115.5**	**102.5**	95.3	90.3	87.2	84.9	83.1	81.0
10	**114.8**	**102.9**	95.7	90.7	87.5	85.1	83.3	81.1
15	**114.1**	**103.0**	96.1	91.0	87.7	85.3	83.4	81.2
20	**113.5**	**102.7**	96.2	91.2	87.9	85.5	83.6	81.3
25	**113.7**	**102.6**	96.2	91.3	88.1	85.6	83.8	81.5
30	**113.4**	**102.4**	96.2	91.5	88.2	85.7	83.8	81.6
35	**113.3**	**102.2**	96.2	91.6	88.3	85.9	83.9	81.7
40	**113.0**	**101.8**	96.2	91.5	88.4	86.0	84.1	81.8
45	**113.1**	**101.7**	96.1	91.6	88.4	86.1	84.1	81.9
50	**113.5**	**101.8**	95.9	91.6	88.5	86.1	84.2	81.9
55	**113.4**	**101.5**	96.0	91.5	88.5	86.2	84.2	82.0
60	**113.6**	**101.4**	95.7	91.5	88.5	86.2	84.4	82.0
65	**113.9**	**101.4**	95.6	91.5	88.5	86.3	84.4	82.1
70	**114.4**	**101.1**	95.7	91.4	88.5	86.3	84.4	82.1
75	**113.8**	**101.2**	95.5	91.4	88.5	86.3	84.4	82.2
80	**117.7**	**101.1**	95.4	91.4	88.5	86.3	84.5	82.3
85	**117.2**	**101.0**	95.3	91.3	88.5	86.4	84.5	82.2
90	**119.0**	**100.9**	95.2	91.1	88.4	86.3	84.5	82.3
95	**120.5**	**101.0**	95.2	91.3	88.5	86.3	84.5	82.3
100	**121.9**	**101.0**	95.3	91.2	88.4	86.3	84.5	82.3
125	**124.8**	**101.0**	95.0	90.7	88.2	86.1	84.6	82.4
150	**124.1**	**100.6**	94.4	90.8	88.0	86.0	84.5	82.4
175	**122.8**	**100.7**	94.3	90.4	87.8	86.0	84.4	82.3
200	**121.3**	**100.8**	94.5	90.3	87.8	85.9	84.2	82.3
225	**119.7**	**100.4**	94.0	89.9	87.7	85.6	84.1	82.2
250	**117.9**	**101.2**	94.3	90.0	87.3	85.5	83.9	82.2
275	**117.1**	**101.3**	94.2	89.9	87.5	85.5	83.9	82.0
300	**115.2**	**101.8**	94.2	89.6	87.4	85.2	83.9	82.0
325	**114.5**	**101.1**	93.9	89.8	87.4	85.0	83.6	81.7
350	**112.6**	**104.9**	93.7	89.6	87.1	84.9	83.4	81.8
375	**112.0**	**106.6**	93.6	89.6	86.8	84.9	83.3	81.6
400	**111.4**	**108.1**	93.6	89.6	86.7	84.9	83.2	81.4
425	**110.9**	**109.3**	93.6	89.7	86.6	85.0	83.2	81.7
450	**108.8**	**110.4**	93.7	89.2	86.5	84.6	83.3	81.3
475	**108.4**	**111.2**	93.9	89.4	86.5	84.8	83.4	81.3
500	**107.9**	**111.9**	94.3	89.7	86.5	84.7	83.0	81.3
525	**107.5**	**111.5**	93.8	89.3	86.6	84.3	83.2	81.4
550	**107.1**	**111.9**	94.3	89.3	86.2	84.3	82.8	81.0
575	**104.9**	**112.1**	93.9	88.9	86.4	84.4	82.8	81.2
600	**104.5**	**111.7**	94.6	89.0	86.7	84.4	82.8	81.4
625	**104.2**	**111.7**	94.2	89.2	86.3	84.1	82.8	81.0
650	**103.8**	**111.4**	95.1	89.3	86.7	84.2	82.9	81.3
675	**103.5**	**111.1**	94.7	89.0	86.4	84.4	82.5	81.0
700	**103.2**	**110.9**	94.4	89.3	86.0	84.1	82.6	80.7
725	**102.9**	**110.6**	98.6	89.0	86.5	84.4	82.8	80.8
750	**102.6**	**110.2**	98.3	89.3	86.2	84.1	82.5	80.8
775	**102.3**	**109.9**	98.0	89.0	85.9	84.5	82.7	80.5
800	**102.0**	**109.6**	97.7	89.4	86.1	84.2	82.4	80.6
825	**101.8**	**109.3**	99.7	89.2	86.3	83.9	82.7	80.8
850	**101.5**	**108.7**	**101.5**	89.7	86.0	84.3	82.4	80.5
875	99.2	**108.5**	**101.3**	89.4	86.2	84.1	82.2	80.7
900	99.0	**108.2**	**102.8**	89.2	86.0	83.9	82.5	80.5
925	98.7	**108.0**	**102.6**	89.8	86.3	84.4	82.3	80.7
950	98.5	**107.1**	**103.9**	89.6	86.0	84.2	82.7	80.5
975	98.3	**106.9**	**103.7**	89.3	86.4	83.9	82.5	80.2
1000	98.1	**106.7**	**103.5**	90.1	86.2	83.7	82.2	80.5

Figure 5 **10 degree Downtilt Field Strength (dBuV/m)**

Antenna Height (m, AGL)

Downtilt 10 degrees	5	15	30	50	70	90	110	140
Distance (m)								
5	117.9	103.5	96.1	91.1	88.0	85.7	83.8	81.7
10	120.2	104.1	96.6	91.5	88.3	85.9	84.0	81.8
15	127.6	104.7	97.1	91.9	88.5	86.1	84.2	82.0
20	124.0	104.8	97.4	92.1	88.8	86.3	84.4	82.1
25	117.1	105.3	97.6	92.4	89.0	86.5	84.6	82.3
30	113.4	105.8	97.7	92.6	89.1	86.6	84.7	82.4
35	110.8	106.3	98.0	92.8	89.4	86.8	84.8	82.5
40	109.0	106.8	98.3	92.8	89.5	87.0	85.0	82.6
45	107.5	107.7	98.5	93.1	89.6	87.1	85.1	82.8
50	106.1	108.7	98.4	93.2	89.8	87.2	85.2	82.8
55	105.3	110.1	98.9	93.1	89.8	87.4	85.2	82.9
60	104.1	112.5	98.7	93.4	89.9	87.4	85.5	83.0
65	103.4	114.9	99.1	93.4	90.0	87.5	85.6	83.1
70	102.3	127.7	99.6	93.5	90.0	87.6	85.5	83.1
75	101.7	129.7	99.7	93.7	90.1	87.7	85.6	83.2
80	101.2	121.9	99.9	93.9	90.2	87.8	85.7	83.4
85	100.6	111.4	100.2	93.8	90.3	87.9	85.8	83.4
90	99.7	109.1	100.6	93.8	90.3	87.8	85.8	83.5
95	99.3	107.9	101.2	94.2	90.5	88.0	85.9	83.5
100	98.8	106.1	101.3	94.2	90.4	87.9	85.9	83.5
125	96.5	101.0	104.7	94.6	90.9	88.1	86.3	83.9
150	94.9	98.1	121.1	95.7	91.3	88.5	86.5	84.0
175	93.3	96.2	110.8	97.1	91.7	88.9	86.7	84.1
200	92.1	94.5	101.4	98.8	92.3	89.3	86.8	84.4
225	91.1	93.0	98.5	101.0	93.2	89.5	87.2	84.5
250	90.2	91.7	96.2	112.0	94.0	90.0	87.4	84.8
275	89.3	90.9	94.2	118.7	95.1	90.4	87.7	85.0
300	88.6	89.7	92.7	106.1	96.4	91.2	88.0	85.2
325	87.9	89.0	91.4	98.8	98.7	91.8	88.5	85.1
350	86.9	88.3	90.8	96.5	107.0	92.6	88.8	85.7
375	86.3	87.4	89.6	94.6	115.7	93.9	89.3	85.7
400	85.7	86.8	89.0	93.0	113.7	95.3	89.9	85.9
425	85.2	86.3	88.0	91.5	103.1	97.4	90.9	86.7
450	84.7	85.8	87.5	90.6	97.0	102.6	91.8	86.6
475	84.2	85.3	86.6	89.4	94.6	112.2	92.4	87.2
500	83.8	84.5	86.1	88.3	92.8	113.5	94.1	88.0
525	83.4	84.1	85.7	87.9	91.7	110.3	95.6	88.3
550	83.0	83.7	84.8	86.8	90.8	100.9	100.8	88.7
575	82.6	83.3	84.5	86.5	89.4	94.8	108.1	89.7
600	82.2	82.9	84.1	86.1	88.6	93.5	111.6	90.4
625	81.9	82.5	83.7	85.2	87.8	92.3	111.3	91.4
650	81.5	82.2	83.0	84.8	86.7	90.5	107.1	92.7
675	81.2	81.9	82.6	84.5	86.4	89.5	99.1	93.4
700	80.9	81.6	82.3	83.7	86.0	88.7	94.3	98.7
725	80.6	81.3	82.0	83.4	85.1	87.8	91.8	104.5
750	80.3	80.6	81.7	83.1	84.8	87.1	90.7	108.2
775	80.0	80.3	81.4	82.8	84.5	86.3	89.6	109.9
800	79.7	80.1	81.2	82.0	83.6	86.1	88.7	108.5
825	79.5	79.8	80.5	81.8	83.3	85.4	87.8	105.0
850	79.2	79.5	80.2	81.5	83.1	84.3	87.0	101.4
875	78.9	79.3	80.0	81.3	82.2	84.1	86.7	92.4
900	78.7	79.0	79.7	81.0	82.0	83.9	86.0	91.0
925	78.5	78.8	79.5	80.3	81.8	82.9	85.2	89.7
950	78.2	78.6	79.3	80.1	81.5	82.7	84.6	89.5
975	78.0	78.3	79.1	79.9	80.8	82.5	84.3	88.4
1000	77.8	78.1	78.8	79.6	80.6	82.3	83.7	87.4